1. Opinions Regarding the Toxicants at Carlisle

All of my opinions as set forth below in this report were reached to a reasonable degree of scientific certainty.

2. Evaluation of the Toxicity of Compounds Associated with the Carlisle Facility

The purpose of this report is to summarize the toxic properties of certain chemicals used by and/or released from the Carlisle facility. The facts and opinions about waste handling, storage, disposal practices, fate, and effects of chemicals used by and/or released from the Carlisle facility are expressed in reports submitted by Bennett & Williams Environmental Consultants and Carpenter Environmental Associates, Inc.

A. Criteria for Identifying Carcinogens

The criteria for identifying carcinogens are as follows:

U.S. Public Health Service, National Toxicology Program (NTP) criteria:

- Group 1: Known to be a carcinogen - based on sufficient human evidence
- Group 2A: Reasonably anticipated to be carcinogenic – based on credible but limited human evidence
- Group 2B: Reasonably anticipated to be carcinogenic - based on sufficient evidence from multiple appropriate animal studies

International Agency for Research on Cancer (IARC) Criteria:

- Group 1: The agent is carcinogenic to humans
- Group 2A: The agent is probably carcinogenic to humans
- Group 2B: The agent is possibly carcinogenic to humans
- Group 3: The agent is not classifiable as to its carcinogenicity to humans
- Group 4: The agent is probably not carcinogenic to humans

B. Toxicity Evaluation of the Organic Chemicals

The first six compounds discussed below are examples of chlorinated solvents. They are also NAPLS (Non-Aqueous Phase Liquids). NAPLS may be DNAPLs (Dense Non-Aqueous Phase Liquids) or LNAPLs (Light Non-Aqueous Phase Liquids). DNAPLS are compounds that are denser than water and sparingly soluble in water. They tend to accumulate below the water table in a separate phase and are a source of groundwater contamination over a long period. LNAPLS are less dense than water. An example of a DNAPL is trichloroethylene (TCE) while an example of an LNAPL is methyl ethyl ketone (MEK).

1. Trichloroethylene (TCE) {CAS 79-01-6}

Trichloroethylene is a clear liquid used as a solvent for cleaning metal parts and as a solvent in glue. Drinking or breathing high levels of trichloroethylene can cause nervous system effects, liver and lung damage, abnormal heartbeat, coma, and possibly death. Rodent bioassays show that high levels of trichloroethylene cause liver, kidney, or lung cancer. Human studies with extended periods of exposure to elevated concentrations of trichloroethylene in drinking water or in workplace air have found evidence of increased cancer. The EPA has established an MCL for trichloroethylene in drinking water of 0.005 mg/L (5 ppb). The NTP has stated that trichloroethylene is Group 2A, reasonably anticipated to be a human carcinogen. IARC has determined that trichloroethylene is Group 2A, probably carcinogenic to humans.

TCE is relatively persistent in subsurface waters owing to the slow rate of biodegradation under anaerobic conditions. This degradation of TCE occurs by reductive dechlorination producing dichloroethene and vinyl chloride.

Expert Report of

Peter S. Thorne, MS, PhD

In the matter of:

Pierre Hodgins vs. Carlisle Engineered Products, Inc. et al.

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B. Toxicity Evaluation of the Organic Chemicals

The first six compounds discussed are examples of chlorinated solvents. The contamination can take the form of light non-aqueous phase liquids (LNAPLs) or be dissolved in the liquid phase. LNAPLs are liquids that have limited solubility in water and are less dense than water.

1. Trichloroethylene (TCE) {CAS 79-01-6}

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TCE is relatively persistent in subsurface waters owing to the slow rate of biodegradation under anaerobic conditions. This degradation of TCE occurs by reductive dechlorination producing dichloroethene and vinyl chloride.

2. Tetrachloroethylene (PERC, Perchlorethylene, PCE) {CAS 127-18-4}

Tetrachloroethylene, or PERC, is used for dry cleaning and degreasing of metal parts. Exposure to high levels of PERC causes dizziness, headaches, lethargy, confusion, nausea, slurred speak, gait disturbance and ultimately loss of consciousness and death. It is a volatile liquid with a sweet odor with a 1 ppm odor threshold. Tetrachloroethylene contaminating water and/or soil can evaporate into the air. Skin irritation may result from repeated dermal contact. Women exposed in industrial settings have exhibited more menstrual dysfunction and spontaneous abortions than unexposed women. NTP lists PERC as reasonably be anticipated to be a carcinogen based on liver tumors in mice and kidney tumors in male rats. IARC finds there is limited evidence in humans for carcinogenicity and sufficient evidence in rodents. IARC lists PERC as probably carcinogenic to humans (Group 2A).

PERC in the soils can leach into groundwater. The persistence in soils can be for years with a small degree of anaerobic bacterial degradation. Perc in the environment degrades into trichloroethylene, 1,2-dichloroethylene, 1,1-dichloroethylene, and vinyl chloride.

3. 1,1,1-Trichloroethane (methyl chloroform) {CAS 71-55-6}

1,1,1-Trichloroethane is a colorless, non-flammable liquid with a chloroform odor. It is widely used as a degreaser, for cold cleaning of metal parts, in glue, and in urethane coating. It also is used in vapor degreasing. Upon exposure at high concentrations it can induce dizziness, confusion, drowsiness, in addition to liver and kidney damage. 1,1,1-Trichloroethane in ground water degrades to 1,1-dichloroethylene.

4. 1,1-Dichloroethane {CAS 75-34-3}

1,1-Dichloroethane is a colorless, non-flammable liquid with a chloroform-like odor. It is highly flammable and is an explosion hazard. It is most often encountered as a solvent and degreasing agent. Similar to several other chlorinated solvents, 1,1-dichloroethane exposure at high concentrations can cause dizziness, confusion, drowsiness, plus liver and kidney damage. There is animal evidence that 1,1-dichloroethane may harm the developing fetus. It can cause eye and skin irritation upon contact.

5. 1,1-Dichloroethene (1,1-Dichloroethylene) (vinylidene chloride) {CAS 75-35-4}

1,1-Dichloroethene is used in the manufacture of polyvinylidene copolymers and as an additive to cement and paints and as a solvent for coating. People are exposed through skin absorption, inhalation, and/or ingestion. 1,1-Dichloroethene has been shown to be harmful to the developing fetus in experimental animals. It also is associated with reproductive impairment in human males. Experimental animals that breathed high levels of 1,1-dichloro-ethene had damaged livers, kidneys, and lungs. The offspring of some of the animals had a higher number of birth defects. Animals that ingested high levels of 1,1-dichloroethene had damaged livers, kidneys, and lungs. The EPA has determined that 1,1-dichloroethene is a possible human carcinogen.

6. 1,2-Dichloroethylene includes:
   cis-1,2-Dichloroethene ((Z)-1,2-dichloroethylene) {CAS 156-59-2}
   1,2-Dichloroethene (cis & trans) (sym-dichloroethylene) {CAS 540-59-0}

1,2-Dichloroethylene includes the cis and trans isomeric forms with similar, but not identical, toxicity. It is a liquid with a mildly acrid odor that finds use in the rubber industry and as a solvent for waxes and resins. The EPA has established a long term health advisory for the cis form. 1,2-

Dichloroethylene can act as a dermal irritant. Systemic exposure causes narcotic effects and dizziness, nausea and vomiting.

7. Naphthalene {CAS 91-20-3}

Naphthalene is a crystalline solid that is used as a feedstock for synthesis of a variety of aromatic compounds and in the manufacture of synthetic resins. Principal routes of exposure are inhalation and ingestion. Naphthalene is a hemolytic agent and an eye irritant. It causes anemia, jaundice, and renal failure. Exposure to large amounts of naphthalene damages red blood cells. Individuals with hereditary deficiency of glucose-6-phosphate dehydrogenase (20% of African Americans, 50% in some Jewish groups) are especially susceptible to the hemolytic effects of naphthalene metabolites. Naphthalene has caused cancer in some animal bioassays. Exposure to large amounts of naphthalene can also cause hemolytic anemia, nausea, vomiting, diarrhea, lung edema, blood in the urine, and a yellow color to the skin. The EPA recommend a limit of 0.5 ppm in drinking water for children. Adults are advised to drink water with no more than 1 ppm. The EPA suggests lifetime consumption of water containing less than 0.1 ppm naphthalene.

8. Methyl ethyl ketone (2-butanone, MEK) {CAS 78-93-3}

Methyl ethyl ketone is a colorless, flammable, volatile liquid with an irritating odor. It is a widely used solvent in a variety of industries including rubber making. MEK causes nose, throat, eye irritation, headache and upper airway irritation. It is also known to cause numbness in the extremities at higher exposures. Animal studies indicate that MEK causes adverse reproductive effects and is an experimental teratogen.

9. Methylene chloride (dichloromethane) {CAS 75-09-2}

Methylene chloride is a non-flammable volatile liquid with a rather pleasant odor. When heated to decomposition, it forms phosgene fumes which are highly toxic. It is used principally in paint thinners and removers, aerosol spray paints, in degreasing operations, and in the production of urethane foam and polycarbonate resins. The principal route of exposure to methylene chloride is by inhalation of the vapors. It is an experimental mutagen and teratogen. In addition to evidence of lung, liver, and mammary carcinogenicity from animal studies, methylene chloride, like some other halogenated hydrocarbons, is also toxic to the heart, causing arrhythmias. Carbon monoxide is a product of the metabolism of methylene chloride and may lead to the formation of carboxyhemoglobin.
NTP Group 2B: Reasonably anticipated to be carcinogenic - based on sufficient evidence from multiple appropriate animal studies.
IARC Group 2B: The agent is possibly carcinogenic to humans.

10. Vinyl Chloride {CAS 75-01-4}

Vinyl chloride is a flammable colorless chemical and is recognized as a breakdown product of TCE and PERC. Vinyl chloride is a known human carcinogen. It has also been reported to be a reproductive hazard for males and females. This finding is supported by extensive animal studies.
NTP Group 1: Known to be a carcinogen - based on sufficient human evidence
IARC Group 1: The agent is carcinogenic to humans

11. 1,3-Butadiene {CAS 106-99-0}

1,3-Butadiene is a colorless gas with a pungent gasoline-like odor. It is used as a polymer component in the production of synthetic rubber and acrylonitrile-butadiene-styrene (ABS) resins used in automobile parts manufacturing. Exposure occurs primarily through the inhalation route. Butadiene is regarded as a teratogen and reproductive hazard as well as a potential carcinogen. Animal studies have demonstrated multiple tumor types in multiple organs. Butadiene is one of the key potential carcinogens of importance in rubber workers.
NTP Group 2B: Reasonably anticipated to be carcinogenic - based on sufficient evidence from multiple appropriate animal studies
IARC Group 2B: The agent is possibly carcinogenic to humans

12. Aroclor-1260 (polychlorinated biphenyl 1260) {CAS 11096-82-5}

Aroclor-1260 is a mixture of some of the 209 congeners of PCBs. PBCs were formerly used as insulating oils and are persistent and highly toxic. Aroclor-1260 is a recognized carcinogen, developmental toxicant, and neurotoxicant. It is also active as an endocrine system toxicant. PCBs were banned in the U.S. in 1977 but are extremely persistent. The NTP has determined that PCBs may reasonably be anticipated to be carcinogens, while the EPA and IARC have determined that PCBs are probably carcinogenic to humans.

13. Polycyclic Aromatic Hydrocarbons

- Acenaphthene {CAS 83-32-9} 2 rings
- Anthracene {CAS 120-12-7} 3 rings
- Benzo(a)anthracene {CAS 56-55-3} 4 rings
- Benzo(b)fluoroanthene {CAS 205-99-2} 4 rings
- Benzo(a)pyrene {CAS 50-32-8} 5 rings
- 1,2,5,6-dibenz(a,h)a anthracene {CAS 53-70-3} 5 rings
- Indeno(1,2,3-cd)pyrene (o-phenylenepyrene) {CAS 193-39-5} 5 rings

This is a large class of toxic compounds, many of which are known human carcinogens (NTP, EPA, and IARC) and carcinogenic in experimental animals. The basic structure is multiple linked benzene rings, often halogenated. They are persistent in the environment and arise from the incomplete combustion of organic material. They are potent inducers of hepatic enzymes and interact with DNA to induce neoplasms. They have received considerable study and have generated much regulatory action.

14. Bis(2-ethylhexyl)phthalate (DEHP, 1,2-Benzenedicarboxylic acid) {CAS 117-81-7}

Bis(2-ethylhexyl)phthlate is a compound added to plastic materials to make them pliable. DEHP is found in an array of plastic products. In soil or water DEHP can be broken down by microorganisms but is persistent when it is deeper in the soil or in sediments. Rodents exposed by ingestion to DEHP exhibited damaged sperm and delayed sexual maturity. High doses of DEHP caused liver damage. The NTP has listed DEHP as reasonably anticipated to be a human carcinogen. The EPA lists DEHP as a probable human carcinogen based on liver cancer in rats and mice.

15. Nitrosamines:

- n - nitrosodimethylamine {CAS 62-75-9
- n - nitrosodiethylamine {CAS 55-18-5
- n - nitrosodibutylamine {CAS 924-16-3
- n – nitroso morpholine {CAS 59-89-2

Nitrosamines are principal components of polycyclic organic matter (synonyms: particulate polycyclic aromatic hydrocarbons, polynuclear aromatics), a grouping for products of sublimation in air of naphthalene and other lower molecular weight polycyclic hydrocarbons. Exposure is principally by the inhalation route. They are generally formed during incomplete combustion of organic compounds. Fifteen of these compounds are recognized animal carcinogens, and mixtures from certain industries are human carcinogens causing tumors of the lung and genitourinary system. Carlisle was notified by an industrial hygienist from the Industrial Commission of Ohio of the carcinogenic properties of these compounds.
NTP Group 2B: Reasonably anticipated to be carcinogenic - based on sufficient evidence from multiple appropriate animal studies for a list of 15 polycyclic aromatic hydrocarbons
IARC Group 2A: The agents are probably carcinogenic to humans

16. Thiourea compounds

- Diethyl-2-thiourea {CAS 105-55-5}
- N,N'-Dibutylthiourea {CAS 109-46-6}
- 2-Imidazolidinethione ethylene thiourea {CAS 96-45-7}
- dimethylethyl thiourea
- trimethyl thiourea {CAS 2489-77-2}
- dialkyl thiourea

These thiourea compounds are used in the manufacture of pesticides, pharmaceuticals, textiles, and rubber. They are dermal sensitizers and there is evidence that inhalation may damage bone marrow and red blood cells. Carlisle was notified by their supplier that diethylthiourea is carcinogenic in animal bioassays and that similar toxicologic properties could be seen with other thiourea compounds.

17. Morpholine-based cure-rite (accelerators)

- 2-(4-morpholinyldithio)-benzothiazole (Morfax) {CAS 95-32-9}
- 4,4'-dithiomorpholine (DTDM) {CAS 103-34-4}
- N-oxydiethylenebenzothiazole-2 sulfenamide (MBS) {CAS 102-77-2}
- Mercaptobenzothiazole for synthesis (MBTS or 2,2'-Dithiobisbenzothiazole) {CAS 120-78-5}
- Mercaptobenzothiazole (MBT) {CAS 149-30-4}
- Morpholine {CAS 110-91-8}

Morpholine-based thiazoles (e.g. Cure-rite® MBS, group: benzathiazole and morpholine-based thiazoles or BMBT) are rubber accelerators. They are metabolized to morpholine and other products and are expected to be more toxic than morpholine. Many are likely skin sensitizers and highly reactive in vivo. According to documents supplied to Carlisle, these chemicals have an objectionable odor and cause rubber dermatitis. Carlisle was notified by its supplier BF Goodrich that these products may be carcinogens and mutagens based on toxicology screening assays and that they should take extra precautions to minimize worker exposure and minimize release.

Morpholine is a synthetic organic chemical used in the manufacture of rubber accelerators and pharmaceuticals. It is also used in optical brighteners, as a corrosion inhibitor, and in waxes and polishes. Morpholine is an irritant in humans and experimental animals. It causes liver and kidney damage in experimental animals.

18. Other Rubber Accelerators

- Ethyl Tellurac {CAS 20941-65-5} (Tellurium diethyl dithiocarbamate)
- Thiram 137-26-8 (aka tetramethylthiuram disulfide, aka thiurad thiram) Vulkacit® Thiuram/C tetramethyl thiuram disulfide (TMTD)
- Butyl zimate (zinc dibutyl dithiocarbamate) {CAS 136-23-2} (may be similar to zinc dimethyl dithiocarbamate {CAS 137-30-4} or zinc dibenzyl dithiocarbamate {CAS 14726-36-4})
- N-tert-butyl-1-2 Benzol Thiazyl Sulfenamide (Santocure NS, Nocceler NS;or Vulkacit® NZ/EGC N-tert-butyl-benzo-thiazyl sulfenamide (TBBS)

Ethyl telluric is an orange to yellow powder used in rubber processing to accelerate vulcanization or the formation of sulfur bridges between rubber polymers that makes the rubber product more rigid. IARC reports that the carcinogenicity of ethyl tellurac was investigated by oral administration and subcutaneous injection in mice of two different strains. There was a significant increase in the number of lung tumors observed in both males and females exposed orally. Overexposure can cause tiredness, nausea, and anorexia.

Thiram is used as a rubber accelerator and vulcanizing compound and also has other uses. In experimental animals it causes skin sensitization, nose and throat irritation, and birth defects. In one rat study, When thiram was administered to rats via the oral route in combination with nitrite, a high incidence of tumors of the nasal cavity was observed in males and females.

C. Toxicity Evaluation of the Metals

Some, but not all, metals are essential to life in trace amounts including selenium, nickel, and iron. They serve to catalyze reactions in the body that involve molecular oxygen. However, when one is exposed to these metals in larger doses they induce oxidative stress, inflammation, cancer, and immune system dysregulation. Some metals can cause immune hypersensitivity while others cause immune hypersensitivity at low exposures and immunosuppression at high exposures (e.g. chromium). While there is some metabolism and excretion of metals, most are excreted slowly. Thus, with regular, chronic exposure one can accumulate a substantial body burden. Some metals accumulate in the bone or other organs while others are disseminated throughout the body.

1. Chromium {CAS 7440-47-3} including Hexavalent Chromium

Chromium exists in the environment as trivalent chromium (Cr III) and hexavalent chromium (Cr VI). Hexavalent chromium is a known human carcinogen (NTP Group 1, IARC Group 1) with sufficient human evidence arising from studies of chromium pigment makers and users. Several other forms of chromium are toxic as well. Trivalent chromium causes contact dermatitis. The hexavalent chromium compounds are readily absorbed via the lungs and the gastrointestinal tract. Cr VI is commonly used in alloy production, welding, industrial chrome plating, steel manufacturing, metal finishing, and wood treatment and is a well-known toxicant. The principal route of entry for chromium is via the respiratory pathway through inhalation of particulate matter (e.g. as dust and adherent to soil particles). Cr III is an essential element in extremely low concentrations but is toxic at higher doses causing pulmonary irritation, central

nervous system effects and allergic dermatitis. Trivalent chromium is not considered carcinogenic to humans. Chromium compounds in the hexavalent state include the chromates, such as potassium dichromate and chrome trioxide. Cr VI is a proven mutagen and carcinogen. Acute exposure to Cr VI results in coughing, wheeze, and shortness of breath. Chronic exposure has been shown to cause nasal ulceration and septal perforation, chronic bronchitis, pneumonia, accelerated loss of lung function and recurrent infection. Epidemiologic studies provide evidence of difficulties with pregnancy and childbirth. Inhaled Cr VI has been demonstrated to cause lung cancer in human and animals. The EPA has classified Cr VI as a Group A Human Carcinogen. IARC has classified Cr VI compounds as Group 1 Carcinogenic to Humans. The National Toxicology Program lists hexavalent chromium compounds as Known Human Carcinogens and specifically cites chrome alloy and chromium-nickel alloy foundry workers as experiencing excess lung cancers. Studies of ferrochrome workers have also demonstrated elevated cancer mortality associated with exposure. Studies have shown that inhalation exposure to low doses of Cr VI is inflammatory and immunostimulatory in the lung, producing a recruitment of neutrophils and monocytes to the lung and increases in inflammatory cytokines including interleukin-1, interleukin-6 and tumor necrosis factor-alpha. At higher concentrations inhaled Cr VI is profoundly immunosuppressive and results in diminished phagocytosis, reduced particle clearance from the lung, and reduced antibody production.

2. Cadmium {CAS 7440-43-9}

Acute inhalation exposure to cadmium causes inflammation of the lung. Chronic inhalation exposure can lead to kidney damage due to cadmium accumulation in that organ and lung cancer. Chronic exposure to cadmium has been shown to produce fetal malformations in animal studies. Cadmium compounds (including cadmium chloride, cadmium oxide, cadmium sulfate, cadmium sulfide) are listed as Group 2B carcinogens (reasonably anticipated to be carcinogenic) by the National Toxicology Program based on sufficient evidence from multiple appropriate animal studies. Cadmium dust and cadmium oxide fumes are severe pulmonary irritants and lead to irreversible emphysematous lung disease with sufficient chronic inhalation exposure. The major concerns regarding chronic exposure are lung cancer and possibly prostate cancer. IARC has classified cadmium and cadmium compounds as Group 1 Carcinogenic to Humans. The National Toxicology Program has classified cadmium and cadmium compounds as Known Human Carcinogens. The EPA considers cadmium a Group B1 Probable Carcinogen.

3. Cobalt {CAS 7440-48-4}

Exposure to higher amounts of cobalt (above trace amounts) can result in lung and heart toxicity and dermatitis. Some workers exposed to cobalt develop fibrosing alveolitis with associated multinucleated giant cells, while others develop occupational asthma as verified by bronchial provocation testing. Animal exposure studies with cobalt dust demonstrate interstitial pneumonitis, lung fibrosis, and granulomatous pneumonia. Liver and kidney effects have also been observed in animals exposed to high levels of cobalt. IARC has classified cobalt and cobalt compounds as Group 2B Possibly Carcinogenic to Humans.

4. Lead {CAS 7439-92-1}

Lead is a toxic soft metal that is associated with anemia, gastrointestinal problems, and neuromuscular weakness. It also causes adverse reproductive effects in both males and females. Certain lead compounds such as lead acetate and lead phosphate are carcinogenic in experimental animals. Lead is very toxic and effects many different organs. Lead can damage to the brain, kidney, and gastrointestinal tract upon acute exposure to relatively high levels.

Chronic exposure to very low levels can lead to impairment of the central nervous system and damage to kidneys and blood. Chronic low-level lead exposure has been shown to induce cognitive impairment in children and reproductive effects in both men and women. Exposure *in utero* can lead to low birth weight and delayed neurobehavioral development. Animal studies have demonstrated that lead is carcinogenic in the kidney leading the EPA to classify lead as a Group B2 Probable Human Carcinogen. IARC lists lead and lead compounds as Group 2B Possibly Carcinogenic to Humans. Lead is regulated as an environmentally persistent pollutant. Body burden is known to increase over time with chronic low level exposure.

5. Beryllium {CAS 7440-41-7}

Beryllium is a hard metal. High exposure to beryllium can cause allergic sensitization and chronic beryllium disease. Lung damage has also been observed in people exposed to high airborne levels. Up to 15% of those occupationally-exposed to airborne beryllium develop CBD and associated lung fibrosis. The general population is generally exposed to low levels of beryllium in air, food, and water that are without adverse effect. People living near industries that use beryllium or near hazardous waste sites may also be exposed to higher than normal levels of beryllium in air. This chronic exposure to beryllium can increase the risk of developing lung cancer. Thus, the NTP and IARC have determined that beryllium is a human carcinogen and the EPA lists beryllium as a probable human carcinogen.

6. Vanadium {CAS 7440-62-2}

Exposure to vanadium can cause harmful health effects including irritation of the eyes, skin, nose and throat leading to coughing, wheezing, chest pain, runny nose, and a sore throat. These effects seen in humans have also been observed in animal toxicology studies. Ferrovanadium particulate matter is normally 50-80% vanadium and has been found to cause lung and eye irritation, bronchitis and pneumonitis. Vanadium oxides damage alveolar macrophages and reduce the lung defense against other environmental contaminants.

7. Thallium {CAS 7440-28-0}

Thallium is often found in combination with halogens such as bromine, chlorine, fluorine, and iodine and as oxide, selenide, acetate, carbonate, and nitrate. Exposure to high levels of thallium is harmful. Workers exposed to thallium by inhalation over several years experienced peripheral nervous system effects, such as numbness of extremities. Studies in people who ingested large amounts of thallium acutely experienced vomiting, diarrhea, hair loss, and effects on the lungs, heart, liver, kidneys, and nervous system. Thallium is a cumulative poison and with long term exposure can cause fatigue, limb pain, peripheral neuritis, protein in the urine and joint pain.

D. Comment on the Toxicity of Mixtures

The toxic profiles of the above compounds represent a synopsis of their effects when exposure occurs individually. Because of the nature of the chemicals discussed herein, it is likely that additive and synergistic effects would occur with combined exposures to these and other chemicals released from the Carlisle facility. Further, exposures to the chemicals herein occurring via multiple routes (i.e. inhalation, ingestion, dermal) would likely lead to greater toxicity than by one route of exposure for one or for multiple compounds.

2. Information Considered in Forming My Opinion

In forming my opinion I relied upon the sources below including standard texts in toxicology; and information from National Toxicology Program, the International Agency for Research on Cancer, the Agency for Toxic Substances and Disease Registry, and the Environmental Protection Agency. I also relied upon my knowledge gained from the peer-reviewed scientific literature. I reserve the right to supplement my report.

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34. Compartive Toxicogenomics Database: accessed at http://ctd.mdibl.org/

4. Qualifications

I am a professor of toxicology and Director of the Environmental Health Sciences Research Center at the University of Iowa, College of Public Health. I hold a B.S. in Chemical Engineering (1978), an M.S. in Biomedical Engineering (1980) and a Ph.D. in Environmental Toxicology (1984), all from the University of Wisconsin. I was a postdoctoral fellow and then assistant professor at the University of Pittsburgh from 1984-1988. I have been on the faculty of the University of Iowa, Department of Occupational and Environmental Health since 1988. I have held the academic rank of assistant professor (1988-1992), associate professor with tenure (1992-1996), and full professor (1996-present). I hold a secondary appointment in the Department of Civil and Environmental Engineering as Professor of Environmental Engineering. I have performed research and taught courses in the fields of toxicology and environmental health for over 19 years.

Appendix A is my curriculum vitae which includes a list of publications I have authored in the past 10 years.

5. Compensation

Compensation for my services as a toxicology expert in this case is $200 per hour. Thus far, I have spent 16.5 hours working on this case.

6. Testimony History

I have testified as an expert at trial or by deposition within the last four years in the following two cases:

- Sherlock Homes versus Margaret Nims, Iowa, 2003
- Cornett versus Welding Alloys, Kentucky, 2004

Appendix A. Curriculum Vitae (includes all publications)